PACIFICORP

APPENDIX TO JUNE 26, 2003 DATA AND FINDING SUMMARY

For

INVESTIGATION OF TECHNICAL ISSUES RELATED TO THE ELECTRIC LAKE AND HUNTINGTON CREEK DRAINAGE CONTROVERSY

July 6, 2004

EXECUTIVE SUMMARY

During discussions with the Utah Division of Oil, Gas and Mining (DOGM) on January 15, 2004, PacifiCorp committed to prepare a data and study update to the June 26, 2003 "Investigation of Technical Issues related to the Electric Lake and Huntington Creek Drainage Controversy". This submittal has been prepared as an Addendum to that document. In preparing this addendum, we have tried to maintain consistency with the June 26th submittal, and provide updated data and conclusions in the same general format as previously submitted. However, new evaluations, data and graphs have been included within sections believed to be the most appropriate based on topic. PacifiCorp will continue to keep DOGM apprized of any new pertinent information at it becomes available.

The data contained within the original June 26, 2003 submittal, along with continued confirming data contained herein, ***clearly*** demonstrates changed hydraulic conditions at Electric Lake. It has been suggested by others that noted impacts on Electric Lake are due to the current drought, and that we should be evaluating "where the water is going" rather than trying to point to the mine as the cause. A continued review of available data leads to the inescapable conclusion that the problems being noted at Electric Lake are in fact a direct result of mining activities conducted by the adjacent Canyon Fuels Skyline Mine.

Extensive studies have been initiated by Canyon Fuels in an attempt to investigate, evaluate, hypothesize, and model alternative explanations for the losses experienced within Electric Lake. The bottom line factor is that there was no earthquake or other natural phenomenon that changed, or could have possibly changed conditions prior to the time that lake losses were found to be occurring. The only real change to surrounding hydrogeology noted to date is that 1) the Skyline Mine conducted mining operations within a very short distance of Electric Lake, 2) the Skyline Mine encountered several inflows as they approached Electric Lake which were significantly, and unexpectedly, higher than historic flows, and 3) encountered water at 10 Left was of such a magnitude that it drove workers from the area, flooded the adjacent mine workings, and has required an investment of millions of dollars to control. All factors point to the conclusion that water entering the Skyline mine has changed local and regional ground water conditions, which in turn has affected the hydrologic balance of Electric Lake.

Comparisons of current versus historic data show that although there have been significant periods of similar drought in times past, there has been no event that rivals, nor can even approximately match the initial and continued response of Electric Lake since 2001. It is further important to note that continued anomalous conditions persist in spite of the best efforts by both the mine and PacifiCorp to offset those losses through ground water pumping and reduced lake outflows.

Conclusions reinforced through a re-evaluation of the updated data presented within this addendum include:

- Water levels and volumes within Electric Lake have been artificially increased since 2001 through well pumping and reduced discharges.

- Without man induced (artificial) inflows from JC-1, JC-3 and from reduced lake outflows, Electric Lake is projected to have dropped below the outlet structure twice since 2002, once between December 2002 and April 2003, and again beginning in December 2003. The significance of these projected events is to say that discharges would have ceased during these periods, leaving PacifiCorp with no available water. Additional data beyond that contained within this report is needed to identify the ending of the second period wherein levels were projected to drop below the outlet structure.
- A total of 18,016 acre-feet of water has either been pumped into or held back in Electric Lake since 2001. Of this, Electric Lake has only seen a maximum storage benefit of 8,184 acre-feet indicating a 55% loss of all pumped or held water. Increased volumes to an already wet lake should have experienced only minor losses, far below those noted.
- Although PacifiCorp's "Lost Water" calculations do not accurately define and calculate all Electric Lake balance components, they are a very good indicator of trends, and very helpful in determining changes which have occurred over time. These calculations must not be over looked nor under estimated.
- Data evaluations included within this report show increasing losses in lake storage at the same time as inflows from wells JC-1 and JC-3 have increased, and discharges have decreased, continuing to indicate a hydraulic connection between the lake and in-mine waters.
- Water loss calculations based strictly on differences in recorded versus adjusted lake volumes (taking out JC-1 and JC-3 inflows and reduced outflows) show an average loss trending from 5.8 to 7.9 cfs (2,600 to 3,545 gpm).
- A comparison of pumped volumes from wells versus resulting volume changes in Electric Lake shows pumping efficiencies between 48 and 62%. These efficiency numbers indicate that between 38 and 52% of all water pumped into the lake is lost. Since well water is discharged directly into Huntington Creek thereby eliminating channel losses, these extreme losses are attributed to increased ground water drawdowns which in turn create increased losses in Electric Lake.
- Water levels within Electric Lake continue to decline in spite of 1) significant action taken to increase inflows (wells JC-1 and JC-3) and reduce outflows (lake discharges over the last two years have been lower than any previously recorded time period), and 2) the fact that the current drought is similar in nature to the five year drought of 1986 - 1991.
- A comparison of average annual changes in lake volume for the comparable drought period of 1988 – 1991 to the current drought period (1999 – present), shows that average lake losses have increased from 2,175 to 5,526 acre-feet/year. This total average change in losses converts to an average flow of 4.6 cfs (2,065 gpm).
- By taking into account artificial or man induced inflows, Electric Lake losses increase to an average of 8,000 ac-ft/yr since 1999, a value ± 6,000 ac-ft/yr higher (400% higher) than for the 1986 – 1991 time period.
- A comparison of lake levels with the Palmer Drought Index shows that although the droughts of 1986 – 1991 and 1999 – present are of similar nature, the lake has responded in a significantly different way. Two very clear observations are that first, lake levels started dropping almost immediately following the start of the drought, and second, lake levels and volumes have decreased far below any prior historic event, in spite of mans attempts to stabilize levels.

- Historic data show very consistent summer depletion trends throughout the history of Electric Lake up through the year 1999, in spite of small fluctuations in rainfall and discharge variations. The consistency of these summer use trends shows and documents the consistency of lake management. Comparisons of the rate of lake level and volume changes during summer use periods since 2001 however show drastic variations from any prior time period. A close look at volume changes since 1999 has also now shown that impacts potentially started as early as the year 1999. It is critical to understand that these changes in use patterns are not a response to the drought since the drought only started in 1999. It takes time for drought impacts to show significant impact as is evidenced by historic summer use pattern and lake level data.
- Comparisons of estimated (via mass balance equations) versus recorded flows within Huntington Creek (since flumes were installed) shows that the error between estimated and recorded flows increases as man induced inflows increase. This increasing error is the result of increased un-measurable lake losses which in turn results from increased ground water withdrawals via in-mine or well pumping.
- It is our understanding that mine personnel have indicated that the fault/fracture system penetrated by well JC-1 is not directly or significantly connected to 10 Left mine workings. This assumption is understood to be based on the fact that pumping 4,200 gpm from well JC-1 only reduced in-mine flows by approximately 600 gpm. As a first order approximation to better understand this issue, the Theis well equation was used to demonstrate that the reduction in flows noted by the mine are in the order of magnitude which would be expected due to well drawdown influence. These relationships show that the existing connection between JC-1 and the mine are not out of line, and are as would be expected.
- Using orifice flow equations, we have approximated future flows based on current flow, current head, and anticipated future head conditions. Following this approach we have determined that:
    - Because of the interconnected nature of abandoned mine workings, post mining potentiometric heads will be significantly lower than pre-mined conditions.
    - Post mining flows through fractures will be significantly different than pre-mined conditions. Some fracture sets previously isolated will now be hydraulically connected with other fracture sets thereby creating modified flow paths. Once hydraulically connected, and under post mining conditions, some existing fracture inflows are shown to have reversed flow, and will thereby be points of discharge rather than sources of recharge. Under post mining conditions, water levels will stabilize at a point where inflows balance outflows. This has been projected to be at an elevation below pre-mined water levels, which will have a continued significant and permanent impact on the local and regional aquifer system.

In summary, there are significant findings which clearly and distinctly point to the conclusion that waters pumped from the Canyon Fuels mine have impacted not only subsurface hydrologic conditions, but also the surface hydrologic conditions of Electric Lake and vicinity. Further details clarifying this statement are provided within the body of this update, and within the attached appendices. Calculations have been provided within the appendices at the request of DOGM as backup to conclusions made. We request that the reader forward questions regarding assumptions made herein, or any perceived discrepancy or perceived error to PacifiCorp.

ELECTRIC LAKE WATER BALANCE SPREADSHEET

The "Electric Lake Water Balance.xls" spreadsheet previously submitted to DOGM has undergone some significant modifications and updates. An updated version is included as part of this submittal in Appendix D. In an effort to help DOGM rapidly understand the content of the spreadsheet, a description of general updates and new content follows:

- Columns that have been used for plotting data that are not significant have been hidden in the spreadsheet to make things less confusing. The user is welcome to unhide them and review them if desired. However, they have not been deleted since they were included on previous submissions, and may still be used in the future. It is important to note however, that they are not considered the main focus of the current investigation and have not been thoroughly checked for accuracy.
- The spreadsheet has been color coded to designate varying input and output types. It is hoped that this color coding will help the reader differentiate between input data versus calculated fields.
- Cell H7 has been included to allow an estimate of lake leakage to be entered. Entry of a value in this cell modifies "calculated" Huntington Creek Flows by adding a lake loss that represents natural seepage outflow.
- Columns F thru J have been added or modified to clearly differentiate between calculated and measured Huntington Creek flows, and to provide a difference between calculated and measured data.
- Columns BG thru BZ were used to review data in a simplistic manner ignoring all but major inflows and outflows. These columns and resulting plot show data similar in nature to that historically prepared by PacifiCorp.
- Columns CB through CW calculate the expected cumulative difference in lake level and volume if Wells JC-1 and JC-3 had not been pumping, nor lake discharges been reduced.
- Columns CY through EA calculate loss ratios by comparing changes in volume to flows either pumped into the lake by JC-1 and JC-3, or artificially held in the lake via reduced outflows.
- Some new graphs have also been added, and all graphs have been updated. Selected new graphs are highlighted herein.

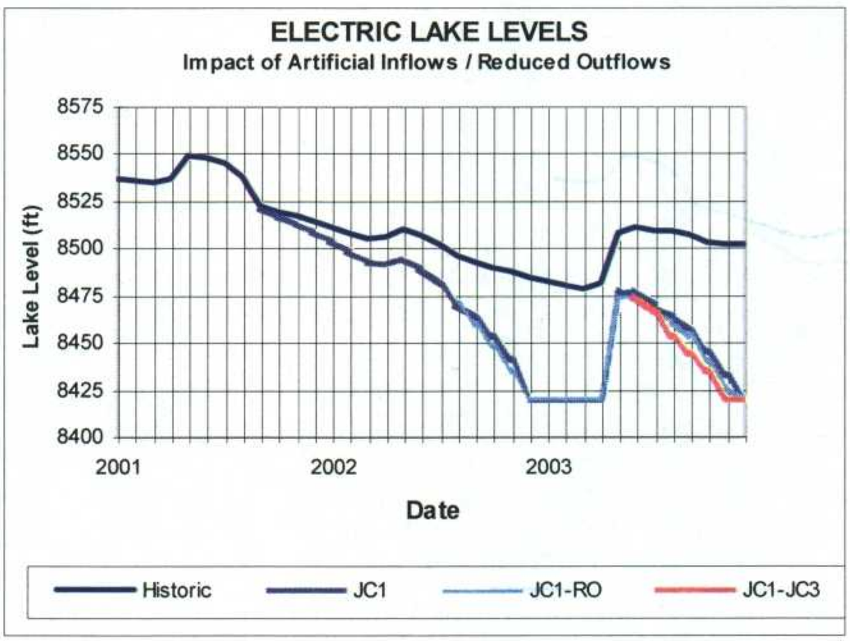
Electric Lake Impact of Artificial Inflows / Reduced Outflows

Water levels and volumes of Electric Lake have been artificially and positively modified over what conditions would have been ever since Well JC-1 was first drilled and put into service by Canyon Fuels Company. Since that time additional man induced impacts have also been noted including a reduction in minimum lake outflows from 12 cfs to 6 cfs (5,385 to 2,693 gpm), and the introduction of water from Well JC-3. The lake outflow reduction was a concession made by Forest Service and the Utah Division of Wildlife Resources to prevent the potentially devastating impacts on fish and wildlife of low lake levels and reduced or eliminated downstream flows. The introduction of flows from JC-1 began in September 2001, the policy to reduce outflows was implemented in September 2002, and Well JC-3 went into service in July of 2003. In general terms, these events have been cumulative over time, and are all man induced by design.

Since these three events are often discussed hereafter in term of their cumulative impact upon lake level and volume, it was felt that abbreviations should be developed whereby they could be easily referenced. Therefore, future discussions related to these cumulative impacts will be texturally referred to as "man induced inflows" or referenced in tables and graphs as follows:

Cumulative Flow Event	Reference made hereafter
Addition of Well JC-1 Inflows	JC1
Addition of Well JC-1 Inflows Reduction of Lake Outflows	JC1-RO
Addition of Well JC-1 Inflows Reduction of Lake Outflows Addition of Well JC-3 Inflows	JC1-JC3

FIGURE 1

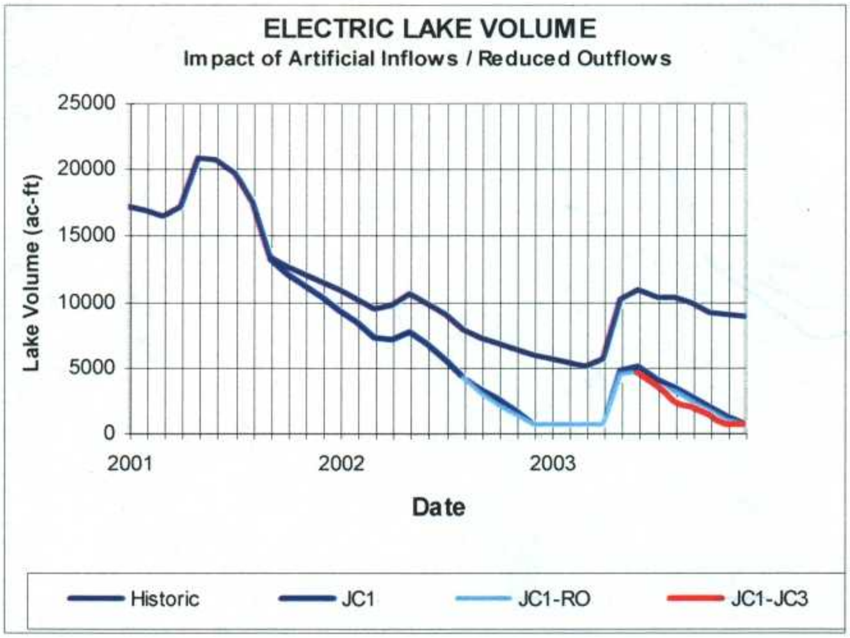


Figures 1 and 2 show the calculated difference between recorded lake levels and volumes respectively versus those that would have been anticipated had JC-1, reduced outflows and JC-3 (condition JC1-JC3) not contributed to lake storage. Note from the graphs that lake levels *__would have dropped below the outlet structure twice__*, once for four months between December of 2002 and April of 2003, and again beginning in December of 2003. As can also be seen from Figure 2 and attached spreadsheet data, man induced inflows into the lake are believed to have artificially maintained lake volumes through December of 2003 by as much as 8,184 acre-feet. This volume of water amounts to an artificial maintenance of lake levels 82 feet higher than would likely have been realized otherwise as seen in Figure 1.

From this data a very interesting fact was identified. That is, a total of 18,016 acre-feet of water was either pumped into or held back in Electric Lake resulting in a total calculated gain of only 8,184 acre-feet. These numbers show a calculated 55% loss (45% efficiency) for all waters pumped into the lake.

FIGURE 2

Lake Loss Calculations



Simple Mass Balance Approach

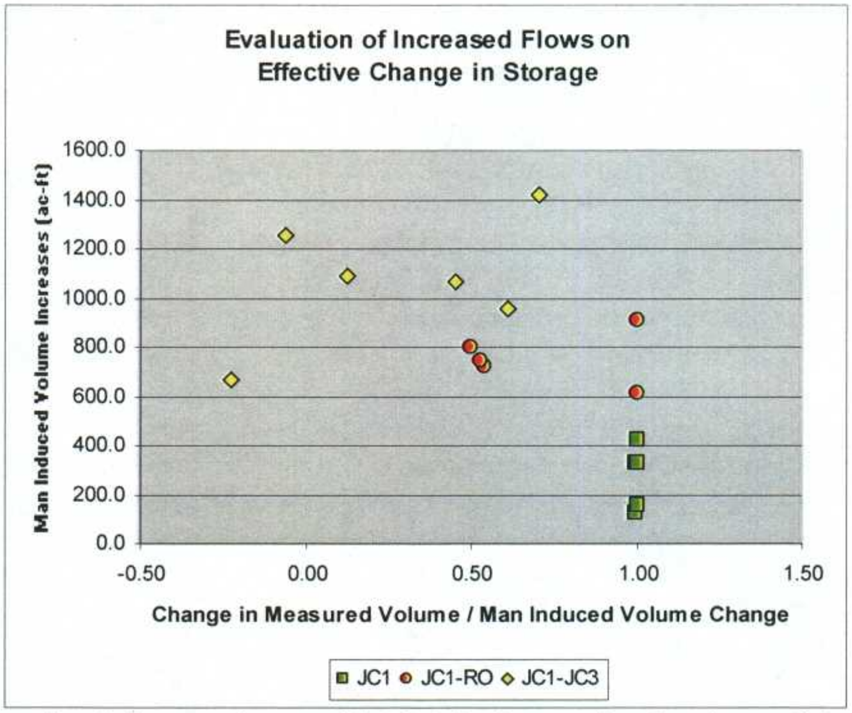
Lake loss estimates have been attempted using various methods and procedures. The simplest most straight forward procedure and method has been used by PacifiCorp wherein "Lost Water" is back calculated from basic data including lake discharges, lake volume, evaporation, and precipitation. This method is used for comparative purposes when direct inflow measurements are not available, and for comparisons of trends between current and historic conditions. Although this data has been criticized by some, it is firmly believed to be a very good representation of *changes* that have been noted. PacifiCorp ***has not*** taken the stand that the data is absolute, but rather relative in nature. When the entire period of record is reviewed using this methodology, it does show a very distinct change in lake characteristics starting in the same period of time as when the mine approached Electric Lake.

Measured vs. Man Induced (Artificial) Volume Approach

An evaluation of data contained within the attached spreadsheet provides a glimpse of loss impacts resulting from pumping and the potential interconnectivity between Electric Lake and in-mine pumping. Figure 3 has been prepared to show how various flow and volume ratios change as pumping and reduced outflows have increased.

The data contained on Figure 3 plot the ratios of increased volume during any given month over the sum of "man induced" or "artificial" inflows for the same month period. The green data shows the ratios while well JC-1 was pumping alone. The Red data shows comparative ratios with both JC-1 and reduced outflow contributions (JC1-RO). The yellow data shows the ratios applicable to periods of time wherein JC-1, JC-3 and reduced outflows (JC1-JC3) were all contributing to sustaining the lake volume. Ratio values below 1.0 indicate a pumping loss since less storage volume was recorded than the volume of water introduced and/or saved. Ratios equal to 1.0 indicate all water pumped into the lake was accounted for through change in lake volume calculations.

FIGURE 3



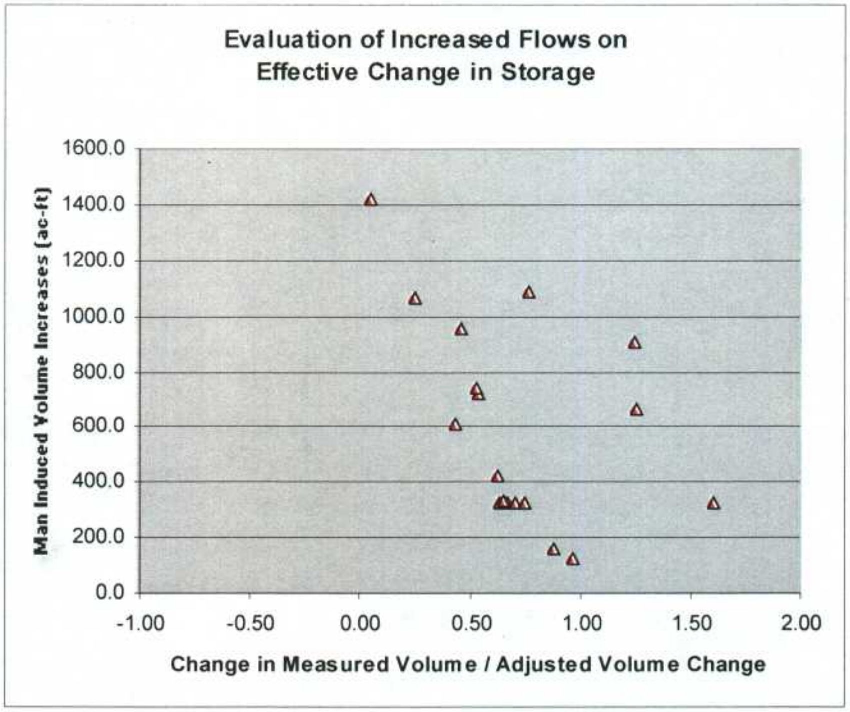
Note from the data shown in Figure 3 that the calculated ratio during the time JC-1 was pumping alone was at a relative value of 1.0. This would tend to indicate that 1) measurements taken during the time JC-1 alone was pumping was insufficient to determine a loss ratio, or 2) that JC-1 showed little impact on lake losses for the data collected.

The next set of data (red data, showing ratios relative to JC-1 and reduced outflows (JC1-RO)) show loss ratios between 0.5 and 1.0. This data could be interpreted as being consistent with JC-1 findings, or be showing a slight increased loss via the data which is shifted to the left. The second set of data was not expected to show significant increased loss impact since 1) the potential for retained storage to increase losses is directly related to elevation head and the orifice equation, and 2) since small changes in head will not typically show significant changes in increased loss. This was earlier confirmed via Figures 1 and 2 where the impact to level and volume resulting from decreased outflows was small.

The third set of data accounting for total artificial inflows (JC1-JC3) however shows a distinct shift to the left, indicating an increase in lake losses with increased pumping. In other words, the graph seems to indicate that lake losses increase with increased pumping. Since JC-3 pumps directly from the 10 Left mains (i.e., the same underground reservoir pool), the same conclusion regarding potential impacts could be inferred regarding potential increases in mine discharges to Eccles Creek.

The set of data shown in Figure 4 takes a different approach to evaluating loss. This set of data calculates the ratio between the difference in recorded lake volumes divided by the difference in adjusted lake volumes after mans influences have been accounted for (JC1- JC3). Note from the graph that the data shows a strong increasing loss with increased flows (i.e., data has an upward and to the left trend). As a point of reference, the four highest combined flow data show ratios significantly less than 1.0.

FIGURE 4



Hand calculations evaluating lake loss from various perspectives are included in Appendix A. The first set of equations evaluates loss during the periods of September 2001 thru November of 2002, and the second during the April 2003 thru November 2003 period wherein the corrected lake level was not projected to drop below the outlet structure. Pumping efficiencies were calculated to be 0.86 (14% loss in pumped water) and 0.44 (56% loss) for the first and second time periods respectively.

Checking losses based strictly on a change in lake volume (recorded volume minus corrected volume) over the same periods of time as above gave gross calculated lake losses of 5.8 and 7.9 cfs (2,600 to 3,545 gpm) respectively.

A check of pumping efficiencies shows that during the May through December 2003 period of time the net difference in measured and corrected lake volumes was 2,759 ac-ft with a corresponding pumped inflow of 5,715 ac-ft. Using these numbers for this period of time produces a pumping efficiency of 48%. A pumping efficiency of 62% was calculated for the September 2001 through December 2003 time period wherein the difference in measured and corrected lake volumes, and pumped inflow was 8,042 and 13,072 ac-ft respectively.

Measured vs. Adjusted Volume Approach

Another check of lake loss was completed by comparing the average annual change in lake volume for comparable drought periods. The first drought period occurring between 1986 and 1991 shows a total loss of lake volume over the five year period of 10,873 ac-ft, or an average loss of 2,175 ac-ft/yr. The current drought period shows that between 1999 and 2003 the lake lost 22,111 ac-ft over a four year period (using corrected lake levels) for an average of 5,528 ac-ft/yr. Subtracting these values and converting to cfs gives an estimated total increased average loss (lake impact) of 4.6 cfs (2,065 gpm). It is our position that actual lake loss is higher than the estimated 4.6 cfs since it is shown elsewhere herein that there is not a direct one to one relationship between man induced inflows and changes in lake storage. In other words, there is a significant portion of flows from JC-1, JC-3, and retained water from reduced outflows that has not been seen to contribute directly to increased lake storage.

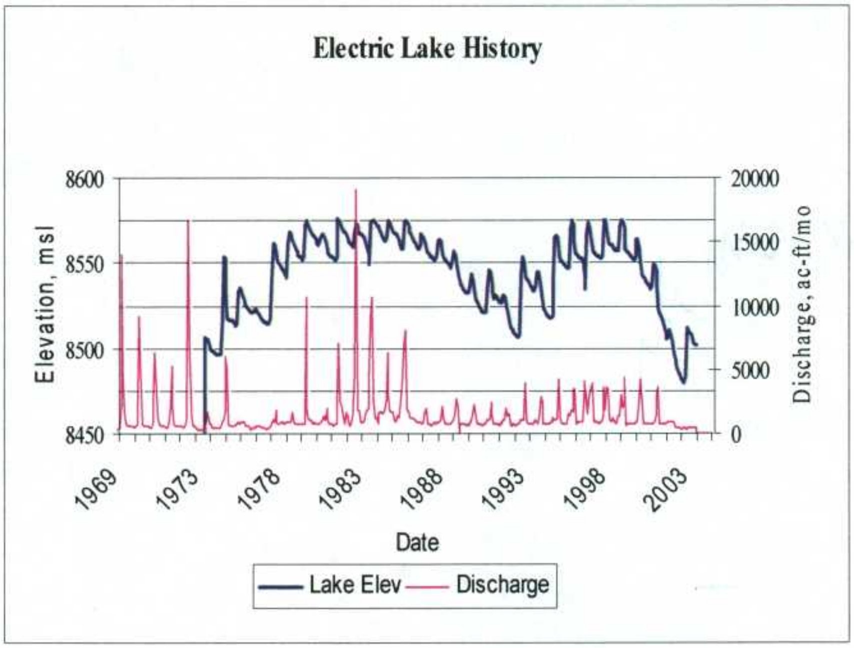
Changed Outflows vs. Man Induced Inflows Approach

Still another method of checking lake loss is to make a direct comparison of changed outflows for similar drought periods versus man induced or artificial inflows. Since the slope of the summer use pattern for 2003 is similar in nature to those identified for pre-1999 periods, one can hypothesize that man induced inflows are helping to sustain lake volumes to pre-impacted conditions. Using this hypothesis, we found that the difference in lake discharge for 1990 versus lake discharge for 2003 was 6,942 ac-ft, and that JC-1 and JC-3 inflows totaled 7,786.2 ac-ft for a total lake impact of 14,728 ac-ft, or 20.3 cfs (9,110 gpm). Making a similar comparison for 2002 yielded a loss estimate of 7,898 ac-ft, or 10.9 cfs (4,892 gpm).

Although variation exists with every method of loss calculation made to date, it is important to note that all methods identify that a significant loss is and has been noted.

GRAPH UDPATES

FIGURE 5



Electric Lake Water Level History

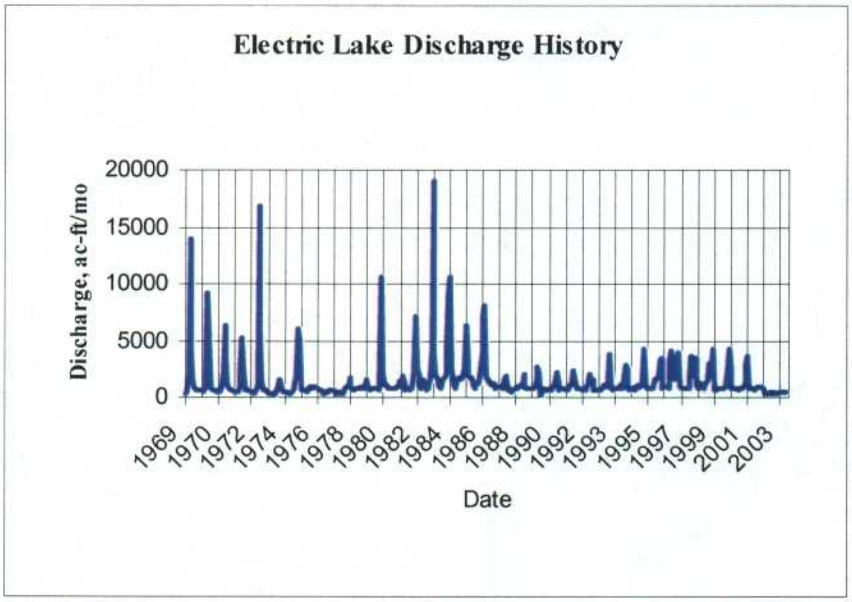
Water levels within Electric Lake continue to decline below any previous historic value as shown in Figure 5. This decline is noted even with the addition of significant artificial inflows from JC-1, JC-3 and reduced outflows totaling over 18,000 acre-feet since September 2001.

Electric Lake Discharge History

Figure 6 shows a significant decrease in Lake discharge that has extended over two years that rivals any known prior record. Lake levels continued to decline in spite of reduced outflows and increased artificial inflows.

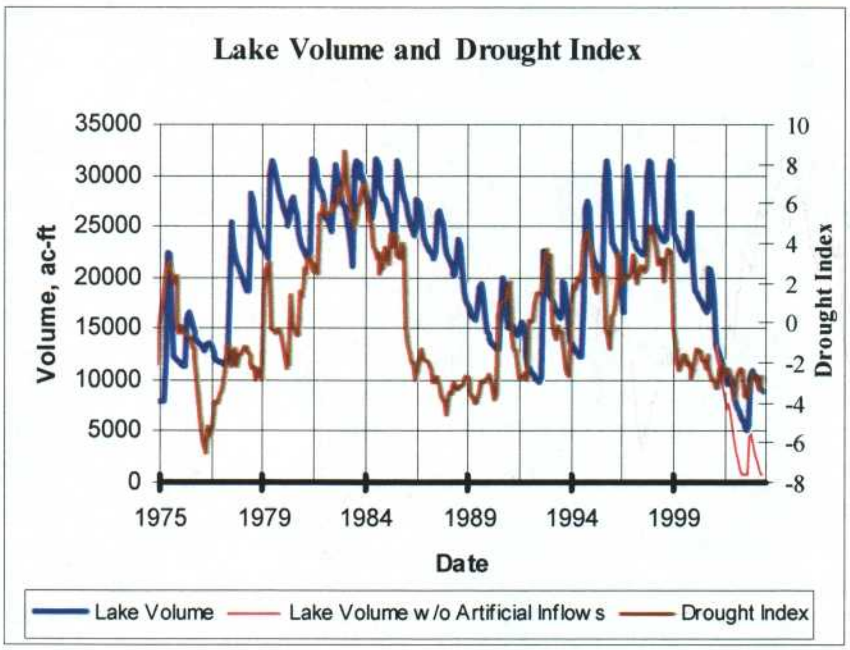
Figure 7 has been updated to show the Palmer Drought Index plotted with lake volume history. Although a similar graph plotted against lake level shows nearly identical results, the graph using volume was used to eliminate controversy regarding the potential misinterpretation of data due to the non linear relationship between lake level and volume. As can be seen, lake volumes continue (through the date of this update) to drop below prior historic events, in spite of the fact that the current drought is similar in nature to the five year drought of 1986 -1991. Again, remember that lake levels are artificially high due to the contributions of man induced inflows.

FIGURE 6



Of particular interest is to note the variations shown in the chart between lake volume and the Palmer Drought Index. In the year 1986 for example, the palmer drought index was at a level near 4, similar to that found in 1999. Immediately thereafter it dropped to a level of near -2 where it basically stayed for four or five years, again similar to that seen since 1999. The general nature of these two drought events is similar, yet lake volumes do not show the same patterns between the two time periods. This is in spite of the fact that lake discharges throughout the noted time period have remained relatively constant as was previously shown in Figure 6.

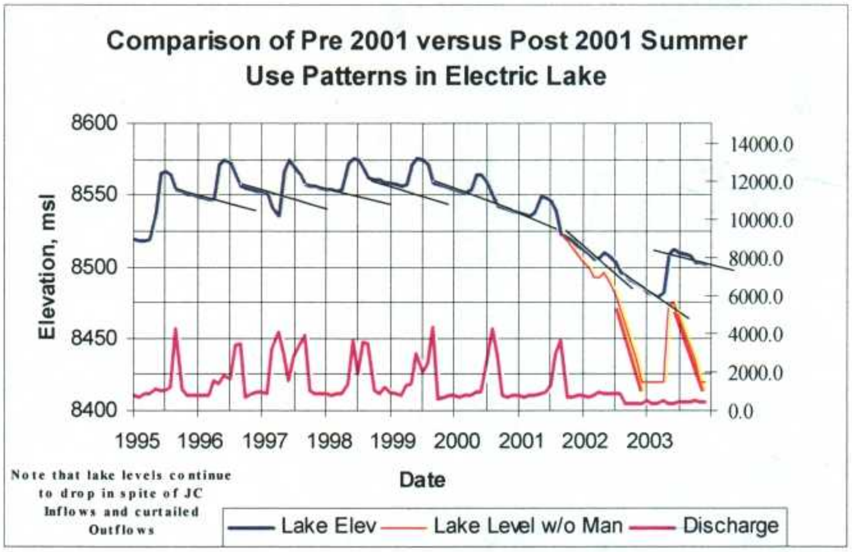
FIGURE 7



During the 1986 to 1991 period the lake volume responded by dropping an estimated 10,000 acre-feet, or an average of 2,000 ac-ft/yr. Within four years following the start of the 1999 drought, lake volumes were recorded to have dropped 14,000 acre-feet, or an average of 3,500 ac-ft/r, and this in spite of the fact that 18,000 ac-ft (4,500 ac-ft/yr) has been added to the lake artificially. Adding both these components indicates that since 1999, the lake has been loosing an average of 8,000 ac-ft/yr, a value 6,000 ac-ft/yr (8.3 cfs or 3,725 gpm)) higher than for the historically similar 1986-1991 period. Note also from Figure 7 the relative rapidity in which water levels dropped following the start of each respective drought period.

Summer Use Patterns

FIGURE 8

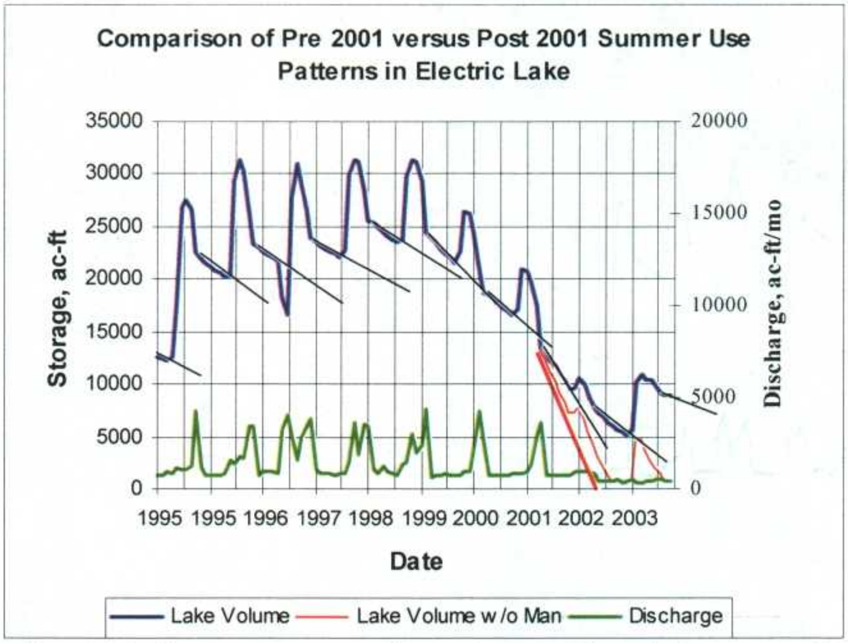


Figures 8 and 9 show a very clear visual image of the impacts noted on the lake since mining occurred in 10 Left. Figure 8 shows 1) the historic water surface elevation of the lake since 1995 (blue) and 2) the calculated water surface elevation without inflows from JC-1, JC-3 or reduced lake outflows (red). Note from the figure the relative consistency between measured summer use patterns (show by the slope of the line added to each summer period event) up until the 2001 period. In 2001 and 2002 however, the slopes of the summer use period change. These steepened slopes indicate a more rapid drawdown that is characteristic of the lake. Even more severe is the slope of the summer use period line when the water level elevation is adjusted for mans influence (addition of JC-1 and JC-3 flows, and reduction of lake discharges).

Also of note in Figure 8 is the return of the summer use slopes to more of a normal condition during 2003. It must be remembered that this return to normal includes artificial inflows from JC-1, JC-3 and from reduced lake outflows.

A plot of the same time period for volume was also prepared to remove any influence of stage-volume variations (see Figure 9). As can be seen, a similar condition and impact on lake hydrology is found regardless of whether levels or volume are considered. As with the prior plot, the increased depletions noted since 2000, and subsequent return to approximate normal slope conditions in 2004 can be seen. This is consistent with the loss, then replacement of water via wells and reduced outflow. Figure 9 however goes one step beyond the analysis shown in Figure 8 in that it demonstrates an impact on lake volumes prior to 2001. Note from the figure that the slope of the summer use depletion line shows a fairly significant change starting in 1999 while discharge data is shown to be fairly consistent. Although not recognized at the time, it would appear that the lake was experiencing impacts as early as 1999. Again, the return of the slope of the summer use depletion lines would appear to be giving an indication that the amount of loss from the lake is likely close in value to the amount of water being artificially held within the reservoir through reduced operational summer time outflows, plus the amount of inflows from wells.

FIGURE 9



Another point brought via a review of Figure 9 is the fact that the changes in summer use occurred too quickly following the start of the drought, to be caused by the drought. In other words, the most recent drought starting in 1999 would not have resulted in an immediate impact as is noted in Figure 9. The visualization of such impacts require the passage of time. This fact can easily be gleaned through a review of summer use patterns following the 1986 – 1991 drought. A similar statement can be made regarding the impacts of 10 Left which are also noted to have occurred immediately.

Huntington Creek Flows

A question and concern that DOGM has had for several months is related to the fact that Huntington Creek inflows have not been measured over historic time, and that data used within spreadsheets was back calculated. It is important to remember several points with this regard.

- First, many evaluations which have been completed do not require inflow to be known. For example, the following comparisons presented herein have been completed independent of inflow data.
  - The evaluation of projected lake levels and volumes without the influence of JC-1, JC-3 and reduced outflows.
  - The Evaluation of Increased Flows on Effective Change in Storage using Man Induced Volume Change.
  - The evaluation of Increased Flows on Effective Change in Storage using Adjusted Volume Change.
  - The presentation and discussion related to Electric Lake History showing dramatic changes in lake performance.
  - Demonstrations of continued lake level and volume declines in spite of decreased outflows.
  - Comparisons between lake levels and volumes versus the Palmer Drought Index.
  - Comparisons of historic and present summer use patterns.
  - Evaluations of projected current and post mining in-mine flows.

- Evaluations of the projected post mining potentiometric water table and a comparison with pre-mined conditions.

- Second, numerical evaluations made by PacifiCorp have been used for several years and show quite effectively the basic conditions related to the reservoir.

- Third, spreadsheet calculations completed by Hansen, Allen & Luce, Inc. have been developed to show and present data using back calculated inflows as well as measured inflows since the data has been available. Regardless of the method employed, data show a consistent conclusion, that is, there has been impact to Electric Lake.

- Fourth, much of the data reviewed has been prepared to visually demonstrate trends and variations or departures from past performance, and hence do not use nor need detailed flow numbers. As long as the same methodology is used to determine Huntington Creek flows, any error in calculation will be consistently employed throughout the analysis and will not impact trends. Hence, trends and variations over time can very effectively demonstrate impacts, and can be just as meaningful as detailed numerical data.

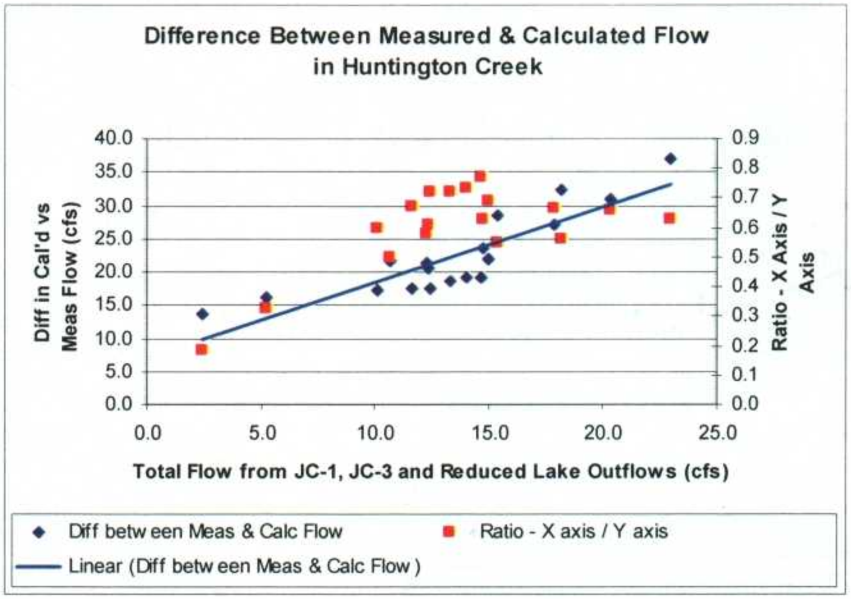
For all intents and purposes, up until the problems were encountered since the early 2000's, a measurement was not needed by PacifiCorp to properly manage and operate Electric Lake. One can not say that the method employed by PacifiCorp to evaluate water supply and demand has not proven to be very effective in managing the resources of Electric Lake and meeting their power supply needs. It wasn't until after mining impacts were suspected that PacifiCorp was forced into the situation wherein they needed to more fully document flows and complete detailed loss evaluations in order to prove that impacts have been noted. Realizing this need, the first measuring station was installed in July of 2002 with a second flume being installed on the creek during the winter of 2003.

Now that stream flow measurements are available, a comparison of calculated inflows to measured inflows can be made. Data shown in columns F through J documents this comparison, and Figure 10 has been added to identify the correlation between the two data sets. As can be seen from the figure, there is a very strong correlation between total lake inflows due to mans influence and the difference between calculated and measured inflows. The correlation between data sets shows that it is increasingly difficult to predict Huntington Creek Flows as contributions from JC-1, JC-3 and reduced lake outflow, increase.

The strong correlation between these two data sets further suggests that there is an additional factor which must be taken into account due to pumping. Some understanding of this additional factor can be gained when a review of the ratio of added flows divided by the difference between

FIGURE 10

calculated and measured inflows is studied as shown in red on Figure 10. For low inflows, the difference between data sets is relatively minor with an error of 20 to 30%, however, for total inflows greater than about 10 cfs (4,488 gpm), this error rises to the 50 to 80% level. We believe this correlation is tied to the fact that additional in-mine pumping lowers the regional water table, and thereby increases gradients and flows from the lake.



In-Mine Flow Evaluation

Three separate evaluations have been made regarding in-mine flows. The first included a determination of how in-mine flows vary with decreasing head while the second determined what inflows might be expected as the mine fills with water following abandonment. The third evaluation attempted to predict water quality with a filling mine. Calculations related to in-mine water is included within Appendix B.

Impact of Decreasing In-Mine Heads on JC-1 Pumping

Well withdrawals from JC-1 has a direct impact on the amount of water entering the mine at the 10-Left mine workings, however, this connection does not have a 1:1 relationship, or in other words is not a straight pipe like connection. In terms of flow, the withdrawal of 2,100 gpm from JC-1 will not, nor would it be expected to reduce mine inflows by the same amount. During discussions with PacifiCorp, mine personnel estimated that pumping from well JC-1 resulted in in-mine flow reductions on the order of 600 gpm. Calculations developed to demonstrate this relationship are shown in Appendix C. Data shown in Appendix C start by determining an equivalent Hydraulic Transmissivity for JC-1 using well test and drawdown data. Calculations within the appendix use the Theis well equation to estimate the amount of drawdown anticipated within the area of the main 10 Left inflow for two different pumped flow conditions, 2,100 and 4,200 gpm.

PacifiCorp understands that the Theis equation theory is based on uniform flow in a homogeneous aquifer, and that it does not fully match the well loss, bedrock, and fracture flow conditions found at well JC-1. It is however a simple and easily understood equation that can be used as a first order approximation of potential drawdowns, which in turn demonstrates similarities to observed conditions by mine personnel. Use of the equation is not meant to be an accurate portrayal of conditions, rather it is meant to serve as an example of hydraulic theory that support noted field conditions. A summary of calculated drawdown data developed through the use of the Theis equation is shown in Table 1.

Using these drawdowns, estimates of flow impacts were made based on two methodologies. The first estimate was obtained using a hypothetical in-mine well with the same characteristics as JC-1. Flows were varied in the well equation until drawdown at the well matched the predicted drawdown at the projected mine location estimated to be between 300 and 600 feet from well JC-1. From Table 1 we see that at the JC-1 flow rates of 2,100 and 4,200 gpm, equivalent flows at distances of 300 and 600 feet required to produce the predicted drawdown were calculated to be 635 and 1,270 gpm respectively.

TABLE 1

JC-1 Flow (gpm)	Radial Distance (ft)	Calculated Drawdown (ft)	Equivalent Well flow at Radial Distance (gpm)
2,100	0	-95	2,100
	150	-43	955
	300	-36	792
	600	-28	635
4,200	0	-188	4,200
	150	-86	1,910
	300	-71	1,580
	600	-57	1,270

The second method employed to check for in-mine impact due to pumping of JC-1 was to evaluate changed flow conditions using the orifice flow equation. Using this method revealed that pumping 4,200 gpm from JC-1 would reduce inflows at distances of 300 and 600 feet to 1,337 and 1,110 gpm respectively.

Similar results are expected regardless of variations in inputs that might be suggested. The bottom line conclusions that can be drawn from this brief review and analysis are:

- Pumping JC-1 will have an impact on aquifer head conditions which will radially decrease as one moves outward from well JC-1.
- Pumping JC-1 will not have a 1:1 impact on in-mine water discharges. Mine personnel have confirmed this fact by indicating that they estimate a 600 gpm impact on mine inflows with JC-1 pumping.
- JC-1 does not intercept all the water moving through the local fault fracture system.
- Higher estimates of potential impact through the equations shown in Appendix C may indicate that other side sources of inflow also enter into the 10 Left area. The fault fracture system intercepted by JC-1 could for example could be interconnected with the fault system directly feeding the 10 Left inflow.

- Local ground water systems are interconnected via faulting and fracturing.

Check of Flow Calculation with Changing Head

Mine inflows can be simulated using the orifice flow equation which is a function of driving pressure head, the open area of the orifice or flow zone, and a constant which is related to the friction or flow restrictive nature of the orifice. In its pure form, the orifice equation is:

$$Q = C\,A\,(2\,g\,h)^{0.5}$$

Where:

C = friction constant
A = orifice area
g = gravitational constant
h = head

Re-arranging the equation by dividing both sides by the square root factor gives:

$$C\,A = Q / (2\,g\,h)^{0.5}$$

Now, since CA for any given orifice or inflow is constant, the equation can be applied to two time periods to determine an unknown. If for example one knows the flow and head conditions at the present time, and the projected head at some point in the future, the equation can be solved for future flow as follows.

$$Q_{present} / (2\,g\,h_{present})^{0.5} = C\,A = Q_{future} / (2\,g\,h_{future})^{0.5}$$

and reduced to:

$$Q_{future} = (Q_{present})\,(h_{future})^{0.5} / (h_{present})^{0.5}$$

Evaluating heads in this manner, provides the means to predict flow was determined for the East Sub-x5, 11-Left-x24, 11-Left-su, and 11-Leftx40 inflow locations as shown in Table 2. Of the four inflow points evaluated, the East Sub-x5 inflow point showed the worst correlation while the remaining 3 locations showed errors between 1 and 33%. Reasons for potential variability in accuracy is due to inaccuracies within the data sets used, including both flow (which was estimated by mine personnel), and with head which was developed from limited available data. In Table 2, for example, the equation for calculating Current Flow for East Sub-x5 is as follows:

$$Q_{future} = (1{,}000)\,(50)^{0.5} / (97)^{0.5} = 718 \text{ gpm}$$

When compared to the estimated flow from mine personnel of 370 gpm, Table 2 shows a 94% error. The error is mostly believed to be the result of both inaccuracies in current in-mine flow estimates, and inaccuracies in both current and estimated future potentiometric water level heads. If for example present flows were really 800 gpm, and future head is 40 feet, the future calculated flow is then reduced to 513 gpm, giving a 39% error in lieu of the 94% error calculated. Although there is error in the estimates, use of these calculations does provide a reasonable estimate of potential future conditions.

TABLE 2

Location	1st Inflow Condition		Current Condition			Error (%)
	Head (ft)	Est. Flow(1)	Head (ft)	Est. Flow(1)	Calc. Flow(1)	Calc. Flow - Est. Flow / Est. Flow
East Sub-x5	97	1,000	50	370	718	94
11-Left-x24	174	1,000	145	900	913	1
11-Left-su	333	1,500	268	1,000	1,346	35
11-Left-x40	232	1,000	191	1,300	908	30

(1) gpm

Anticipated Flow Variation with Mine Abandonment

Upon abandonment, in-mine water levels would rise (if leakage from the area is not excessive) to a topographic high near the south end of the 6 Left mains after which the water would spill northward into adjacent mine workings. Excess water flowing northward into the 14, 15 and 16 Left mains would be pumped to the surface and contribute to Eccles Creek flows. With abandonment, it is anticipated that water quality will decrease as the water moves through, and remains in contact with the abandoned workings. In order to determine the potential impact upon the hydrologic system, post mining flows were calculated for each in-mine source based on the spill elevation as determined by mine personnel.

Calculations included within Appendix B predict that flow for each identified source is expected to vary as shown in Table 3. Note that the net flow for these four sources is projected to reverse. This is significant since it means that long wall mining has opened up the mine workings and created new interconnections between faults that were not previously present. Since mine inflow is a function of mine elevation and potentiometric head, the interconnection of these locations will create a head condition that varies significantly from undisturbed conditions. Some of these variations will include a reversal of flow under assumed post mining conditions.

Using map and flow data provided by the mine and DOGM, we note the following variations between mine inflow locations. Table 3 shows recorded flow data from the four inflow locations during two time periods, first the initial flow, and second the flow estimated to be present during March of 2003. Using this data, coupled with potentiometric head data taken from mine mapping, we have calculated a probable flow given post mining conditions as stated by the mine. Note that all flows are expected to be significantly reduced as water levels attempt to re-stabilize, but even more importantly, two of the faults are projected to have reversed flow under the assumed post mining head condition.

TABLE 3

Location	Estimated Initial Flow gpm	Estimated Mar 2003 Flow, gpm	Calculated Post Mining Flow, gpm
East Sub–x5	1,000	370	170
11-Left-x24	1,000	900	-302
11-Left-x40	1,000	1,000	-1074
11-Left-Setup Room	1,500	1,300	448
Total:	4,500	3,570	-758

Because water can now easily move through abandoned mine workings from one fault zone to another, it is highly improbable that the water level will ever return to pre-mining levels. What is expected to happen is that water will continue to fill and spread through abandoned mine workings until pressures stabilize at a point where inflows balance outflows. This fact was discussed with mine personnel in the summer of 2003. The difference between pre and post mining conditions is that the mining operation has opened up many new relatively unrestrained flow paths that were not present prior to mining. These new flow paths create conditions wherein water can more easily both enter and leave the mine. Experience has shown that once a coal seam has been mined, especially using long wall methods, the potentiometric surface does not return to pre-mined conditions. As a local example we offer the Plateau Mine wherein mining clearly affected the local ground water table and flows in Tie Fork Spring. Documentation clearly shows through the mining record that mine dewatering reduced spring flows, and that following the termination of mining, local ground water was re-directed via abandoned mine workings towards Tie Fork Springs where after flows increased by about 20%.

Calculations performed to determine the approximate level at which the water is anticipated to stabilize within the Skyline Mine have been made as summarized in Table 4. A more detailed spreadsheet of calculations is included within Appendix B.

TABLE 4

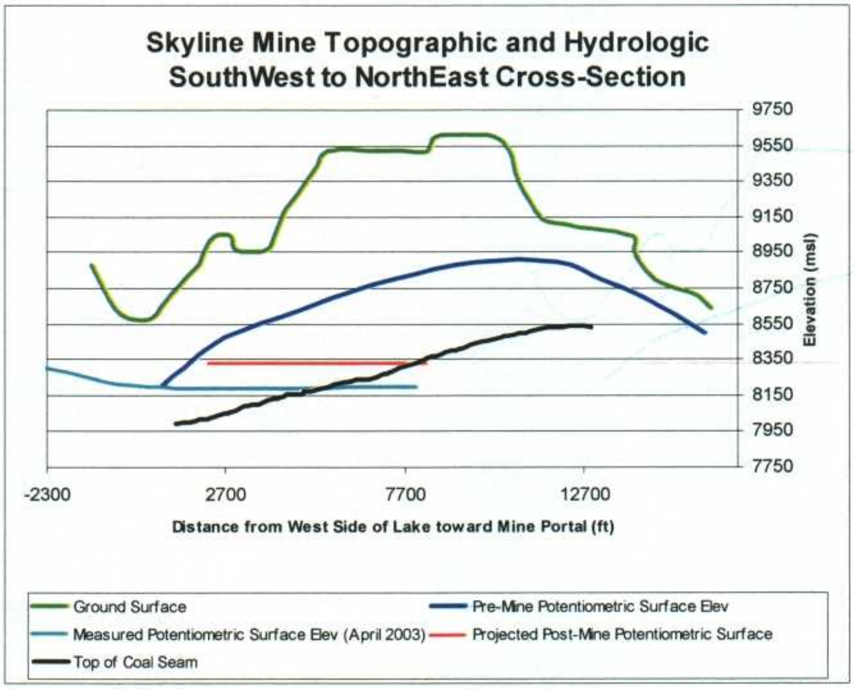
Location	Initial Flow	Post Mine Conditions with Spill to North		Balanced Flow Conditions	
		Elevation	Flow (gpm)	Elevation	Flow (gpm)
11 Left – Setup Room	1,300	8260	448	8328	-6,850
11 Left – HG xc 40	1,000		-302		-582
11 Left – HG xc 24	1,000		-392		479
East Sub xc 5	370		170		761
14 Left HG	1,600		1,431		1,316
16 Left HG	1,200		873		774
Diagonal Fault	1,000		860		769
10 Left – Main Inflow	6,500		4,341		3,332
TOTAL:	13,970		7,429		0

Note from Table 4 that 1) mine inflows will decline, and in some instances even reverse flow direction as the mine fills, and 2) the 8328' msl elevation wherein flows are expected to balance is significantly lower than the pre-mined water table for the general area. Unless post-mining water tables return to pre-mined conditions, there will be a continued and permanent hydrologic effect upon the local and regional aquifer system.

The preliminary topographic and hydrologic cross-section shown in Figure 11 was prepared in order to visually identify the projected impacts to the pre-mined versus post-mine potentiometric surface. The figure was developed within an "Excel" Spreadsheet by extracting data from available mapping in a southwest to northeast direction through the north end of Electric Lake to a point near the mine entry portals in Eccles Canyon. As can be seen in the figure the pre-mined potentiometric surface is shown in a dark blue color with an approximate peak elevation of 8900 feet msl.

During mining the local potentiometric surface was lowered to a level near 8200 feet msl as water was pumped from active mine sections to other mined areas, or to the surface via Eccles Creek. It is important to remember that under flooded abandoned mine conditions, the hydrostatic head will take on a very uniform and generally flat head (visualized as an open reservoir) throughout saturated mine sections, a condition very unlike pre-mined conditions. Under pre-mined conditions, the potentiometric head varied laterally in space as water moved through and around a myriad of geologic conditions, including confining beds, sandstones, faults and fractures, etc.. This general change in potentiometric head is demonstrated in Figure 11 wherein comparisons of the Pre-mined and April 2003 water surfaces are made.

FIGURE 11



The red line shown in Figure 11 represents that level to which the ground water potentiometric surface is anticipated to return to following mining activities. Note the relative flat nature of the projected potentiometric surface and the significant variation it has with pre-mined conditions.

It is PacifiCorp's position that pre and post mined ground water conditions show extreme variation, and that there are and will continue to be significant local and regional hydrogeologic impacts.

Although not completed, similar plots could be developed for other areas within the region. DOGM may desire to have similar plots developed throughout the region to verify and clarify projected ground water level decline impacts. Although not available to PacifiCorp, it is likely that AutoCad or other similar computer files are available to either Canyon Fuels or DOGM that could perform this task relatively easily.

Appendix A
Lake Loss Calculation

HANSEN ALLEN & LUCE inc ENGINEERS

CLIENT PacifiCorp
PROJECT Elec Lake
FEATURE Pumping / Loss Evaluation
PROJECT NO 005.13.100

COMPUTED DEH
CHECKED
DATE 3 FEB 04

CHECK DIFFERENCE IN ΔS IN RESERVOIR VS MINE INFLUENCE

Res would have gone Dry @ 2 times since 2001 had water not have been pumped into Reservoir.

Check 2 time Periods: 9/01 - 11/02, 4/03 - 11/03 } Periods where Res not projected to go dry.

9/01 - 11/02   * - Data taken last day of Month

	9/01*	11/02*	ΔS
Res Volume (ac-ft)	13,414	6,461	-6953 ✓
JC-1 Inflow (ac-ft)	–	–	4724
JC-3 Inflow (ac-ft)	–	–	0
Reduced Outflows (ac-ft)	–	–	1,010
Mod Res Vol (ac-ft)	13,286	1410	-11,876 ✓

JC-1 Inflow + JC-3 Inflow + Reduced Outflows = 5,734

Additional Loss in Res during time period:

$-11,876 + 6953 = -4,923$ ac-ft

Mine Inflow -5734 ac-ft

Loss Ratio: $\Delta S / Q_{in} = \frac{4923}{5734} = 0.86$ (14% loss)

4/03 - 11/03

	4/03	11/03	ΔS
Res Volume (ac-ft)	5,645	9013	3,368
JC-1 (ac-ft)	–	–	3,336
JC-3 (ac-ft)	–	–	1,916
Red. Outflow (ac-ft)	–	–	2,388
Mod Res Vol (ac-ft)	746	752	6

JC-1 + JC-3 + Red. Outflow = 7640

Additional loss $6 - 3368 = -3362$ ac-ft

Mine Inflow $= -7640$

Loss Ratio: $\frac{3362}{7640} = .044$ (56% loss)

Check Avg Loss Rates

9/01 - 11/02 Period

$\Delta S = 10{,}657$ ac-ft over 14 months

$$4{,}923 \frac{\text{ac-ft}}{14\text{ mo}} * \frac{43560\text{ ft}^2}{\text{ac}} * \frac{\text{mo}}{30.5\text{d}} * \frac{\text{d}}{24\text{h}} * \frac{\text{h}}{3600\text{s}} = \underline{5.8 \text{ cfs}}$$

$= 2{,}609$ gpm

4/03 - 11/03 Period

$\Delta S = 3362$ ac-ft over 7 mo

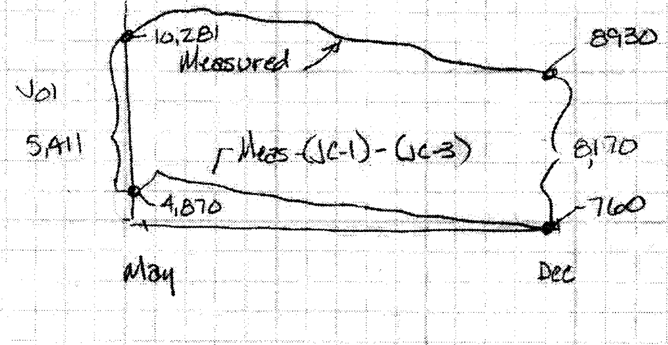
$$\frac{3362}{7} * 43560 * \frac{1}{30.5} * \frac{1}{24} * \frac{1}{3600} = \underline{7.9 \text{ cfs}}$$

$\underline{3{,}563 \text{ gpm}}$

EVALUATE POSSIBLE PUMP RATE IMPACT ON LAKE LOSS
(Compare JC-1,3 inflows vs MEASURED LAKE LOSSES w/o JC-1,3)

- MAKE EVAL DURING PERIODS WHERE LAKE IS NOT PROJECTED TO DRY UP. (ie: Use May - Dec 03)

Measured	ΔVol_{May}	= 10,281	ΔVol_{Dec}	8930
Adjusted	"	= 4,870		- 760
		5411		8,170



HANSEN ALLEN & LUCE inc ENGINEERS

CLIENT PacifiCorp
PROJECT ELEC LAKE
FEATURE LAKE LOSS
PROJECT NO 005.13.100

SHEET 3 OF 3
COMPUTED DEH
CHECKED
DATE 4 FEB 04

NET GAIN OVER 5/03 to 12/03 PERIOD - 5,411
8,170

2759 ac-ft

TOTAL INFLOW FROM JC-1, JC-3 during same period

Mo	JC-1	JC-3
M	511.6	
J	430.0	
J	534.2	98.2
A	468.4	670.4
S	272.5	570.2
O	76.2	326.5
N	538.6	251.0
D	558.5	413.3
	3,384.8	2,329.7

5,714.5 ac-ft

Pumping Effectiveness = 2,759/5715 = 48%

CHECK NET GAIN OVER 9/01 to 12/03 PERIOD

TOTAL ΔV: ΔVol 9/01 = 13414 - 13,286 = 128 } 8170 - 128 = 8,042
ΔVol 12/03 = 8930 - 760 = 8,170 }

FROM ~~SPREADSHEET~~ - FLOW DURING PERIOD IS AS FOLLOWS

JC-1 = 10,742 ac-ft
JC-3 = 2,329.7 ac-ft

13,071.7 ac-ft

Pumping Effectiveness = 8042/13072 = 62%

Check lake loss by comparing 1986-1991 lake vol changes versus changes noted in the 1999-2003 period.

1986-91 (Approx time period)

Taking low Values

Δt = ± 5yrs to drop: 26,046 − 15173 = 10,873
12/31/86 12/31/91

Avg loss rate:

$\frac{10,873}{5}$ = 2175 AF/yr

1999-2001 (Approx time period)

Δt - ± 4yrs to drop: 22857 − 8930 = 13927 (Measured)
12/31/99 12/31/03

Avg loss rate: 22857 − 746 = 22,111 (Corrected)
12/31/03

$\frac{13927}{4}$ = 3,482 AF/yr - Measured

$\frac{22,111}{4}$ = 5,528 AF/yr - Corrected

Δloss = 3,482 - 2175 = 1307 = 1.81cfs - Measured
5,528 − 2175 = 3353 = 4.63cfs - Corrected for Inflows

CHECK AVG DISCHARGES DURING THESE PERIODS

1986-1991 - 62,132 AF

ΣQ = $\frac{62132 \text{ AF}}{5 \text{yrs}}$ = 12,426 AF/yr = 17.16 cfs

1999-2003 - 45394 AF

ΣQ = $\frac{45394 \text{ AF}}{4 \text{yrs}}$ = 11,348 AF/yr = 15.68 cfs

ΔQ = 17.16 − 15.68 = 1.49 cfs

TOTAL LOSS w/ 01

HANSEN ALLEN & LUCE inc ENGINEERS

CLIENT PacifiCorp
PROJECT Elec Lake
FEATURE Loss Estimate
PROJECT NO 005.13.100

SHEET 1 OF 1
COMPUTED DEH
CHECKED
DATE 13 Jan 2004

"Comparison of Pre 2001 versus Post 2001 Summer Use Patterns in Elec Lake"

2003 drawdown slope approximates Pre 2001 conditions. This means that under similar hydrologic conditions, losses can be estimated by evaluating changes in Man induced inflows and reduced outflows

	INFLOWS (ac-ft/mo) JC-1	JC-3	OUTFLOWS 1990*	2003	2002 Evaluation JC-1, JC-3	Outflow
J	Included in JC-3 #	554.3	678.3	525.6	327.4	756.3
F		496.1	656.5	323.3	327.4	683.1
M		516.8	785.9	386.8	327.4	756.3
A		501.5	672.4	480.0	327.5	953.7
M		511.6	993.7	339.2	327.4	902.5
J		430.0	948.1	343.5	330.1	900.5
J		632.4	1,408.3	417.2	327.4	902.5
A		1138.8	2,223.5	457.2	157.8	832.1
S		842.7	1,469.8	470.1	278.4	382.4
O		402.7	708.7	477.4	327.1	386.8
N		789.5	781.5	435.0	416.7	386.8
D		966.8	719.6	449.5	561.7	386.8
		7786.2	12,046.2	5,104.7	4,081.6	8,229.6

ΔOUT = 6,941.5 AF/yr

ΔOUT 12,046.2 − 8,229.6 = 3,816.6

*Taken as representative base year during similar drought

TOTAL IMPACT BY MAN =

2003	2002
7,786.2	4081.6
6,941.5	3816.6
14,727.7 ac-ft/yr	7898.2 ac-ft/yr

Convert to cfs
gpm

2003

$$14{,}727.7\ \frac{AF}{yr} * \frac{43560\ ft^2}{ac} * \frac{yr}{12\ mo} * \frac{mo}{30.5\ d} \times \frac{d}{86{,}400\ s} = 20.3\ cfs$$

9,105 gpm

2002

$$7{,}898.2\ \frac{AF}{Y} = 10.9\ cfs$$

4,883 gpm

Appendix B
In-Mine Flows

Variation in Flow with Head
Flows Following Mine Abandonment
Head at Stabilized Flow

HA&L ENGINEERING

CLIENT	Pacificorp	SHEET	1 OF 2
PROJECT	Electric Lake	COMPUTED	HHM
FEATURE	Hydrology	CHECKED	
PROJECT NO.	605.13.100	DATE	10-16-03

Do variations in mine inflows correspond to changed potentiometric levels due to pumping?

Mine inflows can be modeled using the orifice equation:

$$Q = CA\sqrt{2gh}$$

If flows from the same location are compared at different points in time, then C and A become constants that can be ignored as follows:

$$\frac{Q_1}{\sqrt{2gh_1}} = \cancel{CA} = \frac{Q_2}{\sqrt{2gh_2}} \quad \text{So,} \quad \frac{Q_1}{\sqrt{h_1}} = \frac{Q_2}{\sqrt{h_2}}$$

East Sub XC-5

Inflow Elevation (I_{el}) = 8130 msl (mine contours)
Initial Potentiometric Elevation (P_{1el}) = 8227 msl (W79-35-1A on 10/01)
Potentiometric Elevation of 3/03 (P_{2el}) = 8180 msl (W79-35-1A on 3/03)
Initial Inflow (Q_1) = 1000 gpm (CHIA Table 1)
Later Inflow (Q_2) = 370 gpm (CHIA Table 1 on 3/03) {measured}

Solving for Q_2:

$$Q_2 = \frac{Q_1\sqrt{P_{2el} - I_{el}}}{\sqrt{P_{1el} - I_{el}}} = 1000\frac{\sqrt{8180-8130}}{\sqrt{8227-8130}} = 718 \text{ gpm}$$

$$\text{Error} = \frac{718-370}{370}(100) = 94\%$$

11 Left XC-24

I_{el} = 8035 msl (mine contours)
P_{1el} = 8209 msl (W79-35-1A on 2/02)
P_{2el} = 8180 msl (W79-35-1A on 3/03)
Q_1 = 1000 gpm (CHIA Table 1)
Q_2 = 900 gpm (CHIA Table 1 on 3/03) {measured}

$$Q_2 = 1000\frac{\sqrt{8180-8035}}{\sqrt{8209-8035}} = 913 \text{ gpm}$$

$$\text{Error} = \frac{913-900}{900}(100) = 1\%$$

HA&L ENGINEERING	CLIENT: Pacificorp		SHEET 2 OF 2
	PROJECT: Electric Lake		COMPUTED [illegible]
	FEATURE: Hydrology		CHECKED
	PROJECT NO. 065.134.100		DATE 10-16-03

<u>11 Left Setup</u> (using 98-2-1m data)

I_{el} = 8000 msl (mine contours)
P_{1el} = 8333 msl (interpolation between W79-35-1A and 98-2-1m on 3/15/02)
P_{2el} = 8268 msl (interpolation between W79-35-1A and 98-2-1m on 3/6/03)
Q_1 = 1500 gpm
Q_2 = 1000 gpm {measured}

$$Q_2 = 1500 \frac{\sqrt{8268-8000}}{\sqrt{8333-8000}} = 1346 \text{ gpm}$$

$$\text{Error} = \frac{1346-1000}{1000}(100) = 35\%$$

<u>11 Left Setup</u> (using 98-2-1 data)

I_{el} = 8000 msl (mine contours)
P_{1el} = 8332 msl (interpolation between W79-35-1A and 98-2-1 on 3/15/02)
P_{2el} = 8283 msl (interpolation between W79-35-1A and 98-2-1 on 3/6/03)
Q_1 = 1500 gpm
Q_2 = 1000 gpm {measured}

$$Q_2 = 1500 \frac{\sqrt{8283-8000}}{\sqrt{8332-8000}} = 1385 \text{ gpm}$$

$$\text{Error} = \frac{1385-1000}{1000}(100) = 39\%$$

According to Greg Galeki on 10-16-03, wells 98-2-1m, 98-2-1, and W2-1 are all the same well. I asked Mr. Galeki why the data from 98-2-1m and 98-2-1 do not correspond. He did not know. The above calculations show that the 98-2-1m data might be more reliable, plus it is more complete, so I will use the data from 98-2-1m hereafter.

<u>11 Left XC-40</u>

I_{el} = 8020 msl
P_{1el} = 8252 (interpolation between W79-35-1A and 98-2-1m on 3/15/02)
P_{2el} = 8211 (interpolation between W79-35-1A and 98-2-1m on 3/6/03)
Q_1 = 1000 gpm
Q_2 = 1300 gpm {measured}

$$Q_2 = 1000 \frac{\sqrt{8211-8020}}{\sqrt{8252-8020}} = 907 \text{ gpm}$$

$$\text{Error} = \frac{1300-907}{1300}(100) = 30\%$$

Inflow Location	Inflow Elevation (msl)	Date of Initial Reading	Initial Potentiometric Elevation[1] (msl)	Initial Inflow (gpm)	Date of Subsequent Measurement	Subsequent Potentiometric Elevation[1] (msl)	Calculated Inflow (gpm)	Measured Inflow (gpm)	Error (%)
Gob		Mar-99		400				550	
14-Left		Mar-99		1600				300	
16-Left		Nov-99		1175				300	
Diagonal Flt		Mar-01		1010				300	
10-Left	8064	Aug-01		5450				3200	
East Sub-x5	8130	Oct-01	8227	1000	Nov-02	8180	718	370	94
11-Left-x24	8035	Feb-02	8209	1000	Mar-03	8180	913	900	1
11-Left-su	8000	Mar-02	8333	1500	Mar-03	8268	1346	1000	35
11-Left-x40	8020	Mar-02	8252	1000	Mar-03	8211	908	1300	30

[1] Weighted average (interpolation) of nearby wells on that date (see hand calculations).

HA&L ENGINEERING

CLIENT: PacifiCorp
PROJECT: Electric Lake Hydrology
FEATURE: ΔQ of inflows as mine fills
PROJECT NO.: 005.13.100

SHEET 1 OF 5
COMPUTED: [illegible]
CHECKED: OAI
DATE: 9-26-03

Problem: How does Q change as the mine fills?

At 11-Left Setup Rm:

$Q = 1300 \text{ gpm} \longrightarrow 2.897 \text{ cfs}$

$d = 4 \text{ in.} \longrightarrow A = \frac{\pi (4)^2}{4} \cdot \frac{1}{144} = 0.087 \text{ ft}^2$

$el_{orifice} = 8000 \text{ ft}$

$el_{piez} = 8295 \text{ ft}$ (Ben Miner's contours)

$C = ?$

Use the orifice equation and solve for C.

$Q = CA\sqrt{2gh} \longrightarrow C = \frac{Q}{A\sqrt{2gh}}$

$C = \frac{2.897}{0.087} \cdot \frac{1}{[(2)(32.2)(8295-8000)]^{1/2}} = 0.2416$

When the mine fills:

$Q = ?$

$d =$ same

$el_{spill} = 8260 \text{ ft}$

$el_{piez} =$ same

$C = 0.2416$

Solving for Q:

Back Pressure Head

$Q = (0.2416)(0.087)[(2)(32.2)(8295-8260)]^{1/2} = 1.0 \text{ cfs}$

Driving Head $= 448 \text{ gpm}$

So, $\Delta Q = 448 - 1300 = -852 \text{ gpm}$

Flow Reduction $\frac{1.0}{2.9} = 0.35$ (65% reduction)

At 11-Left HG XC40:

$Q = 1000 \text{ gpm} \longrightarrow 2.228 \text{ cfs}$
$d = 4 \text{ in.} \longrightarrow A = 0.087 \text{ ft}^2$

$el_{orifice} = 8020$ ft.
$el_{piez} = 8240$ ft. (Ben Miner's contours)
$C = ?$

$$C = \frac{2.228}{0.087} \cdot \frac{1}{[(2)(32.2)(8240-8020)]^{1/2}} = 0.2152$$

When the mine fills:

$Q = ?$
$d =$ same
$el_{spill} = 8260$ ft
$el_{piez} =$ same
$C = 0.2152$

Solving for Q:

$$Q = (0.2152)(0.087)[(2)(32.2)(8240-8260)]^{1/2} = \text{negative (no flow)}$$

At 11-Left HG XC24

$el_{orifice} = 8035$ ft
$el_{piez} = 8230$ ft
$el_{spill} = 8260$ ft

$el_{piez} < el_{spill}$ (no flow)

Reverse Flow

$Q = 0.23(0.087)\sqrt{64.4(225)}$

$= -2.39$ cfs

<1,074 gpm>

Flow will reverse with a head of 20'

$Q = 0.2152(0.087)[64.4(20)]^{1/2}$

$= -0.67$ cfs $=$ <302 gpm>

HA&L ENGINEERING

CLIENT: PacifiCorp
PROJECT: Elec Lake
FEATURE: ΔQ mine inflows
PROJECT NO.: 005.13.100

SHEET 3 OF 5
COMPUTED: GLM
CHECKED: DEH
DATE: 9-26-03

At E. Sub. XC5:

$Q = 370\ gpm \longrightarrow 0.8244\ cfs$
$d = 8\ in \longrightarrow A = 0.3491$

$el_{orifice} = 8130\ ft$
$el_{piez} = 8295\ ft$ (Ben Miner's contours)
$C =$

$$C = \frac{0.8244}{0.3491} \cdot \frac{1}{[(2)(32.2)(8295-8130)]^{1/2}} = 0.0229$$

When the mine fills:

$Q = ?$
d - same
$el_{spill} = 8260\ ft$
$el_{piez} = 8295\ ft$
$C = 0.0229$

Solving for Q:

$$Q = (0.0229)(0.3491)[(2)(32.2)(8295-8260)]^{1/2} = 0.4\ cfs$$
$$= 170\ gpm$$

So, $\Delta Q = 170 - 370 = -200\ gpm$

Flow reduction: $\frac{170}{370} = 0.46$ (54% loss)

4/5

TABLE 1 - Water Inflows to Skyline Mine

Inflow Location	Date	Estimated Initial Flow, gpm	Estimated March 2003 Flow, gpm	After the Mine Fills gpm
14-Left HG	03/1999	1,600	300	
16-Left HG	12/1999	1,200	300	
W. Submains (now referenced as Diagonal Fault	03/2000	1,000	300	
10-Left	08/2001	6,500	3,200	
E. Submain XC5	10/2001	1,000	370	170
11-Left HG XC24	02/2002	1,000	900	Ø → - 302gpm
11-Left HG XC40	02/2002	1,000	1,000	Ø → - 1,074gpm
11-Left Setup Rm.	03/2002	1,500	1,300	448
	Totals	14,800	9,300	

These inflows prompted considerable investigations by the mine and outside consultants. They also necessitated a revision to this CHIA in November 2002. All of the inflows were in Mine 2, which proceeded further west than Mine 1 or Mine 3. All inflows are associated with faults and enter the mine through the floor. Based on the investigations of HCI and Petersen (Appendices C, G, and H of July 2002 Addendum to the PHC), it was determined that the water source is the Star Point Sandstone formation located beneath the coal seam. The Star Point Sandstone in the mine area is believed to consist of 14 sandstone layers totaling 743 feet in thickness. Of the five (5) major inflows encountered between March 1999 and October 2001, total inflows have decreased from 11,000 gpm to 4,470 gpm as of June 2003; a 59 percent decrease. As discussed earlier, this formation has a large storage coefficient and relatively high transmissivity. The large network of fracture planes that make up the regional fracture network provide the surface area necessary to drain the water stored in the matrix of the Star Point Sandstone. Based on ^{14}C age dating and Tritium analysis, the water in the Star Point Sandstone is believed to be of ancient origin and represent an isolated groundwater storage volume that is not in direct connection with the surface.

Immediately after the 6,500-gpm inflow, the mine drilled 2 wells into the fault that intercepted the 10-Left inflow location. The intent was to remove groundwater before it entered the mine and thus reduce inflows. Only one well, JC-1, produced appreciable water and is currently pumping at about 4,000 gpm. This pumping was only marginally successful at reducing inflow waters and was estimated to reduce the inflow no more than 800 gpm while the well was pumping 2,200 gpm (HCI).

What head is required to result in a net flow of zero?

Using the orifice equation:

$$Q = CA\sqrt{gh} \longrightarrow \frac{Q}{\sqrt{gh}} = CA$$

Because the characteristics of the orifice remain unchanged, we can relate flow conditions under differing heads as follows:

$$\frac{Q_1}{\sqrt{gh_1}} = CA = \frac{Q_2}{\sqrt{gh_2}} \longrightarrow \frac{Q_1}{\sqrt{h_1}} = \frac{Q_2}{\sqrt{h_2}}$$

By solving for Q_2 and setting it equal to zero, we can solve for the head required over all of the orifices to result in a net inflow of zero.

$$Q_2 = \frac{Q_1\sqrt{h_2}}{\sqrt{h_1}} \longrightarrow 0 = \frac{Q_{A1}\sqrt{h_{A2}}}{\sqrt{h_{A1}}} + \frac{Q_{B1}\sqrt{h_{B2}}}{\sqrt{h_{B1}}} + \cdots$$

Assign letters and data to each mine inflow location:

	Orifice Elevation	Q_1 (gpm)	Initial Water Elevation
A = 14-Left HG	8150	1600	8700
B = 16-Left HG	7980	1200	8575
C = Diagonal Fault	8140	1000	8600
D = 10-Left	8055	6500	8425
E = E. Submain XC5	8130	1000	8600
F = 11-Left HG XC24	8035	1000	8415
G = 11-Left HG XC40	8020	1000	8290
H = 11-Left Setup Room	8000	1500	8015

So,

$$0 = \frac{Q_{A1}\sqrt{h_{A2}}}{\sqrt{h_{A1}}} + \frac{Q_{B1}\sqrt{h_{B2}}}{\sqrt{h_{B1}}} + \frac{Q_{C1}\sqrt{h_{C2}}}{\sqrt{h_{C1}}} + \frac{Q_{D1}\sqrt{h_{D2}}}{\sqrt{h_{D1}}} + \frac{Q_{E1}\sqrt{h_{E2}}}{\sqrt{h_{E1}}} + \frac{Q_{F1}\sqrt{h_{F2}}}{\sqrt{h_{F1}}} +$$

$$\frac{Q_{G1}\sqrt{h_{G2}}}{\sqrt{h_{G1}}} + \frac{Q_{H1}\sqrt{h_{H2}}}{\sqrt{h_{H1}}}$$

The square root does not allow for negative head, so square it to get $0 = \frac{Q_{A1}^2 h_{A2}}{h_{A1}} \cdots$

Evaluation of Flow Variation with Post Mine Flooding

Basis of Evaluation - Orifice Equation: Q = C A (2g h)^0.5

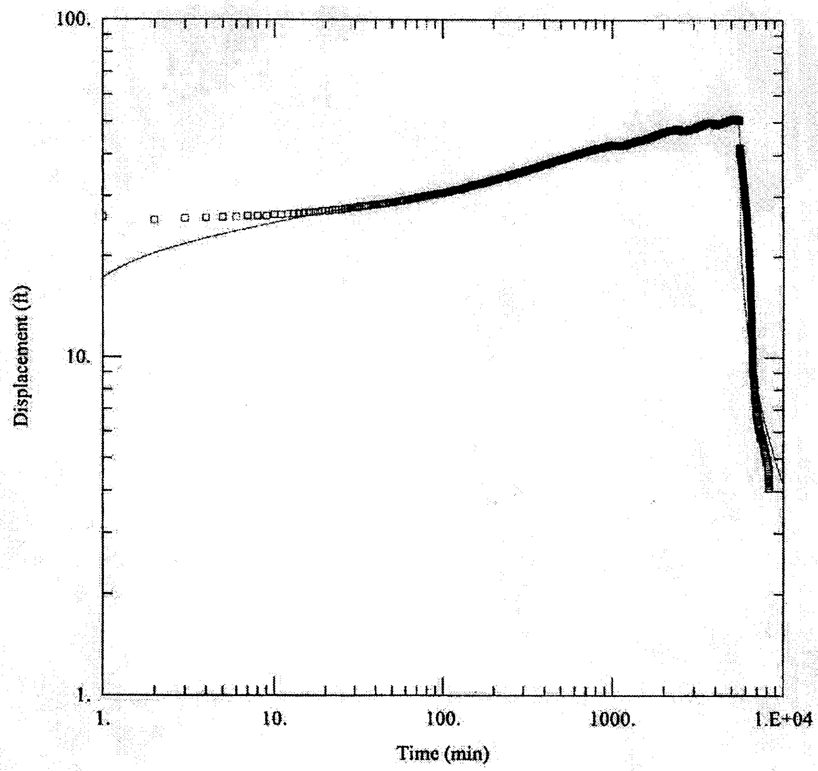
Projected Flows if water were to fill to, and be maintained at the 8260 foot msl overflow location

Location	Mine Elev (msl)	Potentiometric Head (msl)	Diameter (in)	(ft)	Area (ft^2)	Flow (gpm)	(cfs)	Calc'd C Factor	Post Mine Elev (msl)	Projected Flow (cfs)	Projected Flow (gpm)	Delta Flow (cfs)	Delta Flow (gpm)
11-Left - Setup Room	8000	8295	4	0.333	0.087	1,300.0	2.90	0.2408	8260	1.0	447.8	-1.9	-852.2
11-Left - HG xc 40	8020	8240	4	0.333	0.087	1,000.0	2.23	0.2145	8260	-0.7	-301.5	-2.9	-1,301.5
11-Left - HG xc 24	8035	8230	4	0.333	0.087	1,000.0	2.23	0.2278	8260	-0.9	-392.2	-3.1	-1,392.2
East Sub xc 5	8130	8295	8	0.667	0.349	370.0	0.82	0.0229	8260	0.4	170.4	-0.4	-199.6
14 Left HG	8150	8700	4	0.333	0.087	1,600.0	3.57	0.2171	8260	3.2	1,431.1	-0.4	-168.9
16 Left HG	7980	8575	4	0.333	0.087	1,200.0	2.67	0.1565	8260	1.9	873.1	-0.7	-326.9
Diagonal Fault	8140	8600	4	0.333	0.087	1,000.0	2.23	0.1483	8260	1.9	859.7	-0.3	-140.3
10 Left - Main Inflow	8055	8425	4	0.333	0.087	6,500.0	14.48	1.0752	8260	9.7	4,340.6	-4.8	-2,159.4
					Total:	13,970.0	31.1			16.6	7,429.0	-14.6	-6,541.0

Evaluation of Elevation to produce net balance between inflows and outflows for 8 Sources

Location	Mine Elev (msl)	Initial Pot Head (msl)	Diameter (in)	(ft)	Area (ft^2)	Flow (gpm)	(cfs)	Calc'd C Factor	Post Mine Elev (msl)	Projected Flow (cfs)	Projected Flow (gpm)	Delta Flow (cfs)	Delta Flow (gpm)
11-Left - Setup Room	8000	8015	4	0.333	0.087	1,500.0	3.34	1.2323	8327.78	-15.3	-6,849.6	-18.6	-8,349.6
11-Left - HG xc 40	8020	8250	4	0.333	0.087	1,000.0	2.23	0.2098	8327.78	-1.3	-581.5	-3.5	-1,581.5
11-Left - HG xc 24	8035	8415	4	0.333	0.087	1,000.0	2.23	0.1632	8327.78	1.1	479.1	-1.2	-520.9
East Sub xc 5	8130	8600	4	0.333	0.087	1,000.0	2.23	0.1468	8327.78	1.7	761.0	-0.5	-239.0
14 Left HG	8150	8700	4	0.333	0.087	1,600.0	3.57	0.2171	8327.78	2.9	1,316.3	-0.6	-283.7
16 Left HG	7980	8575	4	0.333	0.087	1,200.0	2.67	0.1565	8327.78	1.7	773.5	-1.0	-426.5
Diagonal Fault	8140	8600	4	0.333	0.087	1,000.0	2.23	0.1483	8327.78	1.7	769.3	-0.5	-230.7
10 Left - Main Inflow	8055	8425	4	0.333	0.087	6,500.0	14.48	1.0752	8327.78	7.4	3,331.9	-7.1	-3,168.1
					Total:	14,800.0	33.0			0.0	-0.1	-33.0	-14,800.1

Appendix C
JC-1 Well Impacts



JC-1 PUMP TEST

Data Set:
Date: 02/19/04

Time: 11:44:03

PROJECT INFORMATION

Company: Hansen, Allen & Luce, Inc.
Client: Pacificorp
Project: 005.13.100
Location: James Canyon Well No. 1
Test Well: JC-1
Test Date: 8/23/2002

AQUIFER DATA

Saturated Thickness: 180. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
JC-1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ JC-1	0.5	0.5

SOLUTION

Aquifer Model: Leaky

Solution Method: Moench (Case 2)

T = 6262.3 ft^2/day
r/B = 0.05
Sw = 5.4

S = 0.007082
ß = 0.3507
r(w) = 0.1588 ft

Well Interference Program Using the Theis Solution

Constant Rate / Confined / Fully Penetrating Wells

Condition: *Electric Lake Well JC-1 Impacts on Mine Inflows* Filename: JC-1 Theis Solution

Client: *PacifiCorp Power*
Project Number: *005.13.100*
Well Location: *James Canyon, Electric Lake, Carbon Co, Utah*

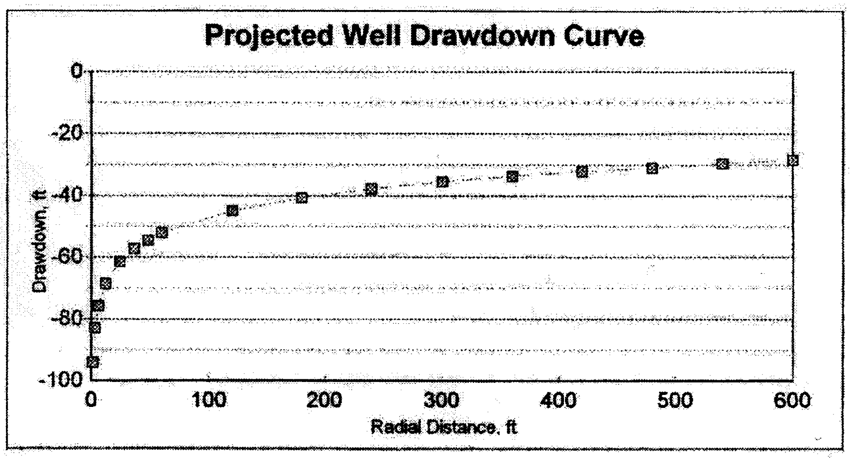
Theis Equations: s = 114.6 Q W(u) / T
u = 1.87 r^2 S / (T t)

where:
s = Drawdown, ft
r = Radius to observation point, ft
T = Transmissivity, gpm/ft
t = Time, days
S = Storage Coefficient
Q = Discharge, gpm

Basic Data

Flow: 2,100 gpm
4.68 cfs
Observation Radius: 600 ft
Transmissivity: 6,262 ft^2/day
46,839.76 gpd/ft
Storage Coefficient: 0.007062
Time: 45 days
W(u): Obtain from Table 8.1 in Freeze & Cherry, 1979 after Wenzel, 1942
Radius Scaling Factor: 10

Radius (ft)	Radius (mi)	u	W(u)	Drawdown
1	0.000	0.0000000	18.307543	-94.06
3	0.001	0.0000001	16.112146	-82.78
6	0.001	0.0000002	14.742622	-75.75
12	0.002	0.0000009	13.335241	-68.52
24	0.005	0.0000036	11.960480	-61.45
36	0.007	0.0000081	11.142860	-57.25
48	0.009	0.0000145	10.626670	-54.60
60	0.011	0.0000226	10.135241	-52.07
120	0.023	0.0000905	8.734765	-44.88
180	0.034	0.0002036	7.925360	-40.72
240	0.045	0.0003619	7.356670	-37.80
300	0.057	0.0005655	6.902146	-35.46
360	0.068	0.0008143	6.534289	-33.57
420	0.080	0.0011083	6.255253	-32.14
480	0.091	0.0014476	6.021146	-30.94
540	0.102	0.0018321	5.755826	-29.57
600	0.114	0.0022619	5.532622	-28.43



Well Interference Program Using the Theis Solution

Constant Rate / Confined / Fully Penetrating Wells

Condition: *Electric Lake Well JC-1 Impacts on Mine Inflows*   Filename: JC-1 Theis Solution

Client: *PacifiCorp Power*
Project Number: *005.13.100*
Well Location: *James Canyon, Electric Lake, Carbon Co, Utah*

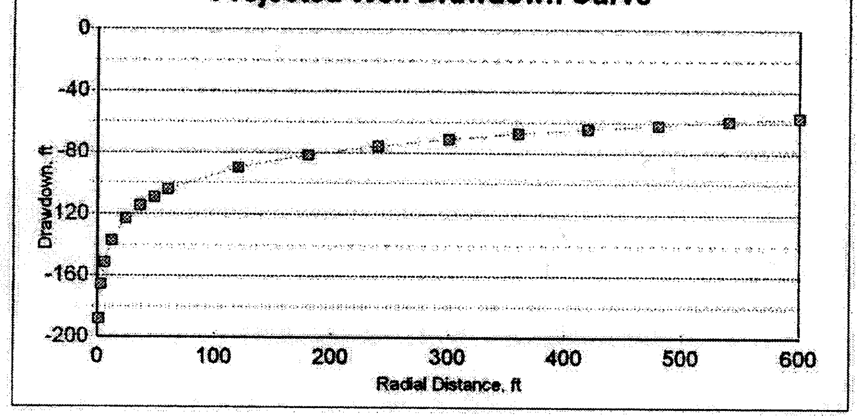
Theis Equations: s = 114.6 Q W(u) / T
u = 1.87 r^2 S / (T t)

where:
s = Drawdown, ft
r = Radius to observation point, ft
T = Transmissivity, gpm/ft
t = Time, days
S = Storage Coefficent
Q = Discharge, gpm

Basic Data

Flow: 4,200 gpm
9.36 cfs
Observation Radius: 600 ft
Transmissivity: 6,262 ft^2/day
46,839.76 gpd/ft
Storage Coefficient: 0.007082
Time: 45 days
W(u): Obtain from Table 8.1 in Freeze & Cherry, 1979 after Wenzel, 1942
Radius Scaling Factor: 10

Radius (ft)	Radius (mi)	u	W(u)	Drawdown
1	0.000	0.0000000	18.307543	-188.13
3	0.001	0.0000001	16.112146	-166.57
6	0.001	0.0000002	14.742622	-151.49
12	0.002	0.0000009	13.335241	-137.03
24	0.005	0.0000036	11.960480	-122.90
36	0.007	0.0000081	11.142860	-114.50
48	0.009	0.0000145	10.626670	-109.20
60	0.011	0.0000226	10.135241	-104.15
120	0.023	0.0000905	8.734765	-89.76
180	0.034	0.0002036	7.925360	-81.44
240	0.045	0.0003619	7.356670	-75.80
300	0.057	0.0005655	6.902146	-70.93
360	0.068	0.0008143	6.534289	-67.15
420	0.080	0.0011083	6.255253	-64.28
480	0.091	0.0014476	6.021146	-61.87
540	0.102	0.0018321	5.755826	-59.16
600	0.114	0.0022619	5.532622	-56.85



HANSEN ALLEN & LUCE inc ENGINEERS

CLIENT PacifiCorp
PROJECT Elec Lake
FEATURE JC-1 Impacts on Mine Inflow
PROJECT NO D05.13.100

SHEET 1 OF 3
COMPUTED DEH
CHECKED
DATE 20 Feb 2004

Re-evaluate potential impacts on mine inflow by Pumping of Well JC-1

Using Artesian & JC-1 TEST DATA:

T = 6,262 ft²/d - Sol. Method: Moench (Case 2)
S = 0.007082 Run w/ Q = 2100 gpm
Sat Thickness = 180'

Using Well Eqns, determine anticipated drawdown effects at mine.

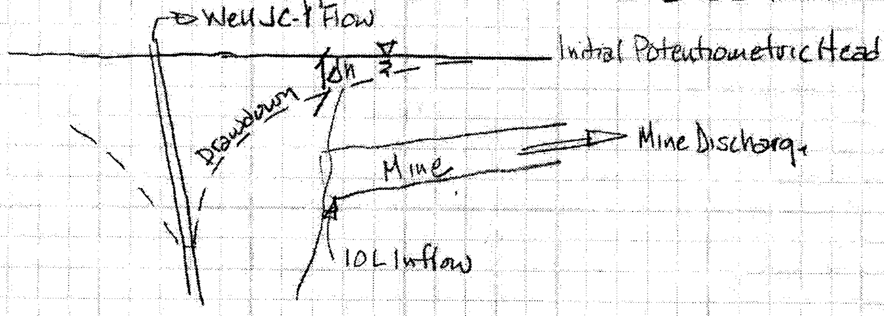
Using JC-1 Theis Solution Spreadsheet,

Flow (gpm)	Distance (ft)	Drawdown (ft)	Well Q @ Mine to Produce Same Drawdown	%
2100	0	-95		
	150	-42.8	955	0.45
	300	-35.5	792	0.38
	600	-28.4	635	0.30
4200	0	-188		
	150	-85.6	1910	0.45
	300	-70.9	1580	0.38
	600	-56.9	1270	0.30

Equivalent well located at mine to produce indicated drawdowns. It is important to note that drawdowns will vary from those shown due to the characteristic under prediction of drawdown in close proximity to the well, therefore, flows would likely be less than shown.

Re-evaluate flow impact by alt method - Orifice Eqn.

Assume fault approximates an orifice @ 10L inflow



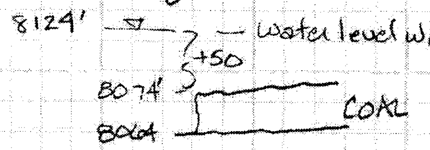
HANSEN ALLEN & LUCE inc ENGINEERS			
CLIENT	PacifiCorp	SHEET	2 OF 3
PROJECT	Elec Lake	COMPUTED	DEH
FEATURE	JC-1 IMPACTS	CHECKED	
PROJECT NO	005.13.100	DATE	20 FEB 04

ORIFICE EQN: $Q = CA\sqrt{2gh}$

Mine Inflow Elev: 8064'   Initial Inflow: 5450gpm

Without good data, make initial estimates of Heads.

JC-3 has $\Delta h \pm 50'$, dropping head to within 10' of bowls.
Assume coal thickness is 10'
Base Orifice Eqn on a relative elev.



Assume $A = \frac{\pi D^2}{4} = \frac{\pi (1)^2}{4} = 0.79 ft^2$

Well Flow (gpm)	Dist. (ft)	Δh (drawdown)	Elev (8124+Δh)	Head (Elev - 8064)
4200				
	150	86	8210	146'
	300	71	8195	131'
	600	57	8181	117'
	0	0	8124	60'

Eval C: from prior Calcs

Loc	C	
11LSetup	0.2416	
11LXC40	0.2152	
11LXC5	0.0229	— OUTLIER
11LXC24	0.2286	

AVG = 0.2284 use $\underline{\underline{0.23}}$

CALC MINE INFLOW $Q = 0.23(0.79)\sqrt{2gh} = 1.4581\sqrt{h}$

Using Dist	h (ft)	Q (cfs)	Q (gpm)
0	60	6.2	2800
150	146	17.6	7907
300	131	16.7	7490
600	117	15.8	7078

Values higher than 2800 reported in Feb 03
Calibrate Area

$A = \frac{Q}{C\sqrt{2gh}} = \frac{(2800/448.8)}{0.23\sqrt{2g(60)}} = 0.4364 ft^2$

HANSEN ALLEN & LUCE inc ENGINEERS

CLIENT PacifiCorp
PROJECT Elec Lake
FEATURE JC-1 Impacts
PROJECT NO 005.13.100

SHEET 3 OF 3
COMPUTED DEH
CHECKED
DATE 20FEB04

RE-EVAL MINE INFLOWS USING $A = 0.4364$, $C = 0.23$

$Q = .4364(.23)\sqrt{2gh}$

USING DIST	h	(gpm) Q	(cfs) Q	(gpm) ΔQ
0	60	6.2	2800	
150	146	9.7	4368	1568
300	131	9.2	4137	1337
600	117	8.7	3910	1110

Conclusion: CALC'S SHOW THAT WITHDRAWING WATER FROM JC-1 IS EXPECTED TO HAVE AN IMPACT ON MINE DISCHARGES, BUT NOT @ 100%. IMPACTS WILL DEPEND ON DIST. FROM JC-1, AND JC-1 WITHDRAWALS

EVALUATION IS BASED ON THE THEIS EQN AS AN APPROXIMATION OR SAMPLE OF POTENTIAL IMPACTS. SINCE SYSTEM IS FAULT / FRACTURE, IMPACTS WILL VARY, BUT WILL CERTAINLY NOT SHOW A 1 TO 1 CORRELATION.

IF ALL WATER PUMPED FROM JC-1 WERE EQUAL TO REDUCTIONS IN MINE DISCHARGES, IT WOULD INDICATE THAT JC-1 IS FEEDING 100% FROM THE MINE. THE FACT IT DOESN'T MEANS IT RECEIVED RECHARGE FROM OTHER SOURCES WHILE IMPACTING MINE INFLOWS.

Appendix D
Electric Lake Water Balance.xls